PATENT ABSTRACTS OF JAPAN

(11)Publication number : 2002-237684
(43)Date of publication of application : 23.08.2002

(51)Int.CI. H05K 3/46
G02B 6/122
H05K 1/02

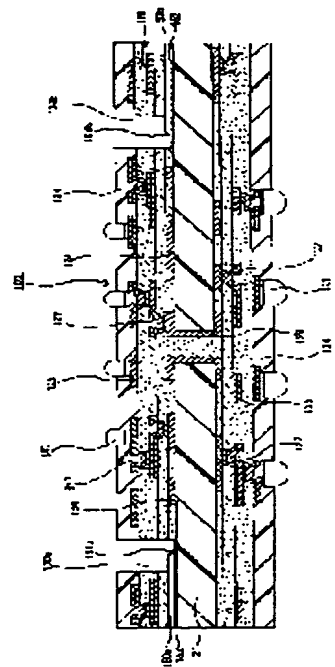
(21)Application number : 2001-298091
(22)Date of filing : 27.09.2001

(71)Applicant : IBIDEN CO LTD
(72)Inventor : ASAI MOTOO

(30)Priority
Priority number : 2000371882 Priority date : 06.12.2000 Priority country : JP

(54) MULTILAYER PRINTED CIRCUIT BOARD

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a multilayer printed circuit board, capable of preventing occurrences of cracks or the like in the board or an interlayer resin insulating layer, when an optical waveguide to be incorporated in the multilayer printed circuit board, or particularly, when an optical path conversion mirror is formed by using mechanical processing or the like and having superior connection reliability of light signals.
SOLUTION: The multilayer printed circuit board comprises a conductor circuit and an interlayer resin insulating layer laminated and formed on both surfaces of a substrate, and the optical waveguide formed on the substrate and the circuit board further comprises an elastic material layer formed between the substrate and the optical waveguide. .



LEGAL STATUS
[Date of request for examination]
[Date of sending the examiner's decision of rejection]
[Kind of final disposal of application other than the examiner's decision of rejection or application converted registration]
[Date of final disposal for application]
[Patent number]
[Date of registration]
[Number of appeal against examiner's decision

of rejection]
[Date of requesting appeal against examiner's decision of rejection]
[Date of extinction of right]

* NOTICES *

CLAIMS

[Claim(s)]
[Claim 1] both sides of a substrate -- a conductor -- the multilayer printed wiring board which is a multilayer printed wiring board with which optical waveguide was formed on said substrate, and is characterized by forming the elastic material layer between said substrates and said optical waveguides while laminating formation of a circuit and the resin insulating layer between layers is carried out.
[Claim 2] both sides of a substrate -- a conductor -- the multilayer printed wiring board which is a multilayer printed wiring board with which optical waveguide was formed on the resin insulating layer between layers of the outermost layer, and is characterized by forming the elastic material layer between the resin insulating layer between layers of said outermost layer, and said optical waveguide while laminating formation of a circuit and the resin insulating layer between layers is carried out.
[Claim 3] Said elastic material layer is a multilayer printed wiring board according to claim 1 or 2 whose elastic modulus is 2.5x103 or less MPas.
[Claim 4] Said elastic modulus is a multilayer printed wiring board according to claim 3 which is 1.0-1.0x103MPa.
[Claim 5] Said elastic material layer is a multilayer printed wiring board given in any 1 of claims 1-4 which consist of polyolefine system resin and/or polyimide resin.

[Translation done.]

DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to a multilayer printed wiring board.
[0002]
[Description of the Prior Art] In recent years, attentions have gathered for the optical fiber focusing on the communication link field. In especially IT (information technology) field, the communication technology which used the optical fiber for maintenance of the high-speed Internet network is needed. In the communication system using the optical fiber which has the descriptions, such as ** low loss, ** high bandwidth, ** narrow diameter and a light weight, no ** guiding, and ** saving resources, and has this description, compared with the communication system using the conventional metallic cable, the number of repeaters can be reduced sharply, construction and maintenance become easy, and an optical fiber can attain economization of communication system, and high-reliability-ization.
[0003] Moreover, since an optical fiber can multiplex the light of the wavelength from which not only the light of one wavelength but many differ to coincidence with one optical fiber, it can realize the transmission line of the large capacity which can respond to various applications, and can respond to image service etc.
[0004] Then, in network communication, such as such the Internet, using the optical communication using an optical fiber not only for the communication link of a backbone but for the communication link with a backbone and terminal equipments (a personal computer, mobile one, game, etc.) and the communication link of terminal equipments is proposed. Thus, when using optical communication for the communication link with a backbone and a terminal equipment etc., in order for IC which performs information (signal) processing in a terminal equipment to operate with an electrical signal, it is necessary to attach the equipment (henceforth light/electric transducer) which changes the lightwave signal and electrical signal of optical -> electric transducer, electric -> phototransducer, etc. into a terminal equipment. So, in the conventional terminal equipment, the optical waveguide which transmits the lightwave signal sent from the outside through an optical fiber etc. to light/electric transducer, for example, or transmits the lightwave signal sent from light/electric transducer to an optical fiber etc., and the multilayer printed wiring board which transmits an electrical signal through a solder bump were mounted separately, and a signal transmission and signal processing were performed.
[0005] Since optical waveguide and a multilayer printed wiring board were separately mounted in such a conventional terminal equipment, it was difficult for the whole equipment to become large and to achieve the miniaturization of a terminal equipment. Then, this invention persons proposed previously the multilayer printed wiring board with which optical waveguide was formed in the interior and front face as a multilayer printed wiring board which can be contributed to the miniaturization of a terminal equipment.
[0006]
[Problem(s) to be Solved by the Invention] Moreover, in the optical waveguide built in such a multilayer printed wiring board, in order to connect efficiently an optical element and optical waveguides, such as an optical fiber, a photo detector, and a light emitting device, the optical-path conversion mirror is formed in the edge, and such an optical-path conversion mirror was usually formed of diamond saw **** machining of 90 degrees of V types etc.
[0007] By the optical-path conversion mirror formed using such machining etc., when forming this optical-path conversion mirror, big stress will be applied to a substrate or the resin insulating layer between layers, and the crack might occur in the substrate or the resin insulating layer between layers with this stress. Moreover, in this case, although the multilayer printed wiring board with which optical waveguide was formed also by sticking the optical waveguide of the shape of a film of having formed the optical-path conversion mirror could be manufactured, when sticking optical waveguide, the blemish, the crack, etc. might occur in the optical waveguide which stress was applied to this optical waveguide, consequently was stuck.
[0008]

[Means for Solving the Problem] Then, by making it the configuration in which optical waveguide was formed through the elastic material layer on the substrate and the resin insulating layer between layers, as a result of inquiring wholeheartedly, in order that this invention persons may solve the above-mentioned problem At the time of optical waveguide formation, especially, it could prevent that a crack occurred in a substrate or the resin insulating layer between layers at the time of optical-path conversion mirror formation, and this invention which shows becoming the multilayer printed wiring board excellent in dependability to a header and the following was completed. In addition, it found out that it could prevent that can ease the stress concerning optical waveguide and a blemish, a crack, etc. occur in optical waveguide by the above-mentioned elastic material layer at the time of optical waveguide formation in sticking the optical waveguide which formed the optical-path conversion mirror beforehand.

[0009] namely, the multilayer printed wiring board of the first this invention — both sides of a substrate — a conductor — while laminating formation of a circuit and the resin insulating layer between layers is carried out, it is the multilayer printed wiring board with which optical waveguide was formed on the above-mentioned substrate, and is characterized by forming the elastic material layer between the above-mentioned substrate and the above-mentioned optical waveguide.

[0010] the multilayer printed wiring board of the second this invention — both sides of a substrate — a conductor — while laminating formation of a circuit and the resin insulating layer between layers is carried out, it is the multilayer printed wiring board with which optical waveguide was formed on the resin insulating layer between layers of the outermost layer, and is characterized by forming the elastic material layer between the resin insulating layer between layers of the above-mentioned outermost layer, and the above-mentioned optical waveguide.

[0011] In the multilayer printed wiring board of the first or the second this invention, as for the above-mentioned elastic material layer, it is desirable for an elastic modulus to be 2.5x103 or less MPas, and, as for the above-mentioned elastic modulus, it is more desirable that it is 1.0-1.0x103MPa. Moreover, as for the above-mentioned elastic material layer, in the multilayer printed wiring board of the first or the second this invention, it is desirable to consist of polyolefine system resin and/or polyimide resin.

[0012]

[Embodiment of the Invention] First, the multilayer printed wiring board of the first this invention is explained. the multilayer printed wiring board of the first this invention — both sides of a substrate — a conductor — while laminating formation of a circuit and the resin insulating layer between layers is carried out, it is the multilayer printed wiring board with which optical waveguide was formed on the above-mentioned substrate, and is characterized by forming the elastic material layer between the above-mentioned substrate and the above-mentioned optical waveguide.

[0013] In the multilayer printed wiring board of the first this invention, since optical waveguide is formed through the elastic material layer on the substrate, at the time of optical waveguide formation, in case an optical-path conversion mirror is especially formed in optical waveguide, the stress concerning a substrate can be eased, and the crack resulting from this stress etc. can prevent generating in a substrate. Therefore, the fall of the dependability of a multilayer printed wiring board is not caused by the crack generated in the substrate. In addition, it can prevent that can ease the stress concerning optical waveguide and a blemish, a crack, etc. occur in optical waveguide by the above-mentioned elastic material layer at the time of optical waveguide formation in sticking the optical waveguide of the shape of a film which formed the optical-path conversion mirror beforehand.

[0014] moreover — the above-mentioned multilayer printed wiring board — a conductor — since both a lightwave signal and an electrical signal can be transmitted since a circuit and optical waveguide are formed, and optical waveguide is built in in the multilayer printed wiring board, it can contribute to the miniaturization of the terminal equipment for optical communication.

[0015] The multilayer printed wiring board of the first this invention is a multilayer printed wiring board with which optical waveguide was formed on the substrate, and the elastic material layer is formed between the above-mentioned substrate and the above-mentioned optical waveguide. As the above-mentioned elastic material layer, a being [the elastic modulus / below 2.5x103MPa (250kgf/mm2)] thing is desirable, and what is 1.0-1.0x103MPa (0.1-100kgf/mm2) is more desirable. When the above-mentioned elastic modulus exceeds 2.5x103MPa, at the time of optical waveguide formation especially The stress applied to a substrate in case an optical-path conversion mirror is formed in optical waveguide cannot fully be eased. It is because the stress applied to optical waveguide by considering the difference of the coefficient of thermal expansion of optical waveguide, and a substrate and the resin insulating layer between layers as a cause cannot fully be eased in addition to the ability not to prevent that a crack etc. occurs in a substrate but a crack may occur in optical waveguide. Furthermore, when performing formation of optical waveguide by sticking film-like optical waveguide,

stress concerning optical waveguide cannot fully be eased, but a blemish, a crack, etc. may occur in optical waveguide. Moreover, what consists of the polyolefine system resin and/or polyimide system resin which have the elastic modulus of the above-mentioned range as the concrete quality of the material of the above-mentioned elastic material layer is desirable. In addition, the formation approach of the above-mentioned elastic material layer is explained in full detail behind.
[0016] In the multilayer printed wiring board of the first this invention, optical waveguide is formed on the above-mentioned elastic material layer. The inorganic system optical waveguide which consists of the organic system optical waveguide and quartz glass which consist for example, of a polymer ingredient etc., a compound semiconductor, etc. as the above-mentioned optical waveguide is mentioned. In these, organic system optical waveguide is desirable. While excelling in adhesion with a substrate or the resin insulating layer between layers, it is because it can be formed and processed easily.
[0017] The resin complex of the resin and thermosetting resin with which it was not limited as the above-mentioned polymer ingredient especially when there was little absorption by the communication link wavelength range, for example, some of thermosetting resin, thermoplastics, photopolymers, and thermosetting resin were photosensitivity-ized, and thermoplastics, the complex of a photopolymer and thermoplastics, etc. are mentioned.
[0018] Specifically, silicone resin, such as polyimide resin, such as acrylic resin, such as PMMA (polymethylmethacrylate), Deuteration PMMA, and heavy hydrogen fluorination PMMA, and fluorination polyimide, an epoxy resin, UV hardenability epoxy resin, polyolefine system resin, and deuteration silicone resin, the polymer manufactured from benz-cyclo-butene are mentioned.
[0019] Particles, such as for example, a resin particle, an inorganic particle, and metal particles, may be contained in the above-mentioned optical waveguide in addition to the above-mentioned resinous principle. What consists of resin complex of thermosetting resin, thermoplastics, a photopolymer, the resin with which some thermosetting resin was photosensitivity-ized, thermosetting resin, and thermoplastics, complex of a photopolymer and thermoplastics, etc. as the above-mentioned resin particle, for example is mentioned.
[0020] Specifically For example, an epoxy resin, phenol resin, polyimide resin, Thermosetting resin, such as a bismaleimide resin, polyphenylene resin, polyolefin resin, and a fluororesin; The heat-curing radical of these thermosetting resin A methacrylic acid, an acrylic acid, etc. are made to react to (for example, the epoxy group in an epoxy resin). Resin which gave the acrylic radical; Phenoxy resin, polyether sulfone (PES), Thermoplastics, such as polysulfone (PSF), a polyphenylene sulfone (PPS), polyphenylene sulfide (PPES), a polyphenyl ether (PPE), and polyether imide (PI); what consists of photopolymers, such as acrylic resin, etc. is mentioned. Moreover, what consists of resin complex of the resin complex of the above-mentioned thermosetting resin and the above-mentioned thermoplastics, the resin which gave the above-mentioned acrylic radical, the above-mentioned photopolymer, and the above-mentioned thermoplastics can also be used. Moreover, the resin particle which consists of rubber can also be used as the above-mentioned resin particle.
[0021] Moreover, as the above-mentioned inorganic particle, what consists of titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, and basic magnesium carbonate, a silica, and a zeolite, and a titania, etc. is mentioned, for example. Moreover, what was made to mix and carry out melting of a silica and the titania at a fixed rate, and was equalized may be used. Moreover, what consists of Lynn or phosphorus compounds can also be used as the above-mentioned inorganic particle.
[0022] As the above-mentioned metal particles, what consists of gold, silver, copper, palladium, nickel, platinum, iron, zinc, lead, aluminum, magnesium, calcium, etc. is mentioned, for example. These resin particles, an inorganic particle, and metal particles may be used independently, and may be used together two or more sorts.
[0023] Moreover, especially the configuration of the above-mentioned particle is not limited, for example, the shape of a globular shape, an ellipse globular shape, the letter of crushing, and a polyhedron etc. is mentioned. In these, the shape of a globular shape or an ellipse ball is desirable. It is because there is no angle in the particle of the shape of the shape of a ball, or an ellipse ball, so it is harder to generate a crack etc. in optical waveguide.

[0024] Moreover, as for the particle size of the above-mentioned particle, it is desirable that it is shorter than communication link wavelength. It is because transmission of a lightwave signal may be checked when particle size is longer than communication link wavelength. As mean particle diameter of a concrete particle, 0.1-20 micrometers is desirable and 0.5-10 micrometers is desirable especially. As long as it is the range of this particle size, the particle of two or more kinds of different particle size may be contained. That is, it is the case where the particle whose mean particle diameter is 0.5-4 micrometers, and the particle whose mean particle diameter is 1-10 micrometers are contained etc. In addition, in this specification, the particle size of a particle means the

die length of the longest part of a particle.
[0025] As for the loadings of the particle which the above-mentioned optical waveguide contains, it is desirable that it is 10 - 80 % of the weight, and it is more desirable that it is 20 - 70 % of the weight. It is because transmission of a lightwave signal may be checked when the effectiveness with which a particle will be combined if the loadings of a particle are less than 10 % of the weight may not be acquired and the loadings of a particle exceed 80 % of the weight. Moreover, although especially the configuration of the above-mentioned optical waveguide is not limited, since the formation is easy, the shape of a sheet is desirable.
[0026] Thus, when optical waveguide is made to contain a particle, adjustment of a coefficient of thermal expansion can be aimed at between optical waveguide, the substrate which constitutes a multilayer printed wiring board, the resin insulating layer between layers, etc., and it is harder coming to generate a crack, exfoliation, etc. resulting from the difference of a coefficient of thermal expansion. In addition, since the expansion coefficient of the direction of a field in contact with the substrate of optical waveguide etc. and the expansion coefficient of the direction which intersects perpendicularly with a substrate etc. are abbreviation homogeneity, the optical waveguide containing a particle does not almost have that the balance in the TM0 mode of optical waveguide and the TE0 mode collapses, either. Therefore, the transmission loss of the lightwave signal resulting from these can be controlled, and a lightwave signal can be transmitted good.
[0027] Moreover, the thickness of the above-mentioned optical waveguide has desirable 5-50 micrometers. Moreover, the width of face of the above-mentioned optical waveguide has desirable 5-50 micrometers. the conductor which constitutes a multilayer printed wiring board if the above-mentioned width of face is not sometimes easy for the formation in less than 5 micrometers and the above-mentioned width of face exceeds 50 micrometers on the other hand — it may become the cause which checks the degree of freedom of designs, such as a circuit
[0028] Moreover, the ratio of the thickness of the above-mentioned optical waveguide and width of face has a desirable way near 1:1. It is because the loss at the time of transmitting a lightwave signal becomes larger as the ratio of the above-mentioned thickness and width of face shifts from 1:1. Furthermore, when the above-mentioned optical waveguide is the optical waveguide of the single mode which is the communication link wavelength of 1.55 micrometers, as for the thickness and width of face, it is more desirable that it is 5-15 micrometers, and when the above-mentioned optical waveguide is the optical waveguide of a multimode on the communication link wavelength of 0.85 micrometers, it is more desirable [the thickness and width of face] that it is 20-80 micrometers.
[0029] Moreover, as the above-mentioned optical waveguide, it is desirable to form the optical waveguide for light-receiving and the optical waveguide for luminescence. In addition, the above-mentioned optical waveguide for light-receiving means the optical waveguide for transmitting the lightwave signal sent from the outside through an optical fiber etc. to a photo detector, and the above-mentioned optical waveguide for luminescence means the optical waveguide for transmitting the lightwave signal sent from the light emitting device to an optical fiber etc. Moreover, it is desirable for the above-mentioned optical waveguide for light-receiving and the above-mentioned optical waveguide for luminescence to be what consists of the same ingredient. It is because adjustment of a coefficient of thermal expansion etc. is easy for a scale or the formation to like.
[0030] It is desirable to form the optical-path conversion mirror in the above-mentioned optical waveguide, as mentioned above. By forming an optical-path conversion mirror, it is because it is possible to change an optical path into a desired include angle. Formation of the above-mentioned optical-path conversion mirror can be performed by cutting the end of optical waveguide so that it may mention later.
[0031] Moreover, in the multilayer printed wiring board of the first this invention, since optical waveguide is formed in a part of front face of a substrate, it is desirable to form opening for optical paths for transmitting a lightwave signal between this optical waveguide and external optical elements (a photo detector, a light emitting device, optical fiber, etc.). It is desirable to specifically form in one side of a substrate opening for optical paths which penetrates the resin insulating layer between layers by which laminating formation was carried out. Moreover, when the solder resist layer is formed in the outermost layer of a multilayer printed wiring board so that it may mention later, it is desirable to form opening for optical paths which penetrates the solder resist layer of one side and the resin insulating layer between layers and which was open for free passage. Moreover, the inside of the above-mentioned opening for optical paths may be filled up with the resin which does not check transmission of a lightwave signal, for example, the resin used for the above-mentioned optical waveguide, the same resin, etc. By filling up the inside of opening for optical paths with resin, it is because the optical waveguide formed on the substrate can be protected.
[0032] moreover, the conductor which sandwiched the resin insulating layer between layers in the above-mentioned multilayer printed wiring board — it is desirable between circuits for the Bahia hall to connect. a conductor — connecting circuits in the Bahia hall — a conductor — while being able to wire a circuit by high

density — a conductor — the degree of freedom of a design of a circuit improves. moreover, the above — a conductor — as it is in explanation of the manufacture approach of the multilayer printed wiring board mentioned later, as for a circuit, being formed by the additive process is desirable. an additive process — the spacing — the conductor of detailed wiring of 50 micrometers or less — it is because it is suitable for forming a circuit. In addition, the above-mentioned additive process may be a fully-additive process, and may be a semiadditive process. moreover, the above — a conductor — the circuit may be formed by the build up method.
[0033] Moreover, it is desirable to form a solder resist layer in the outermost layer, and to form opening for mounting opening for mounting the substrate for IC chip mounting in this solder resist layer and various surface mount mold electronic parts in the above-mentioned multilayer printed wiring board. The above-mentioned opening is formed in a solder resist layer, further, when the pad for surface mounts is formed if needed, a solder bump can be formed, or PGA (Pin Grid Array) and BGA (Ball Grid Array) can be arranged, and, thereby, a multilayer printed wiring board, an external substrate, etc. can be connected electrically. Moreover, the substrate for IC chip mounting and surface mount mold electronic parts can be mounted in a multilayer printed wiring board by connecting the above-mentioned solder bump, the bump formed in BGA and surface mount mold electronic parts of the substrate for IC chip mounting even if it did not form BGA and PGA, and the above-mentioned pad for surface mounts.
[0034] Moreover, in the multilayer printed wiring board of the first this invention, when the external substrates (substrate for IC chip mounting etc.) with which optical elements, such as a light emitting device and a photo detector, were mounted are connected to the side in which the above-mentioned optical waveguide is formed through a solder bump, the above-mentioned multilayer printed wiring board and the above-mentioned external substrate can be certainly arranged to a position according to the self-alignment operation which solder has. Therefore, if the installation location of the optical waveguide in the multilayer printed wiring board of the first this invention and the installation location of the optical element in the above-mentioned external substrate are exact, an exact lightwave signal can be transmitted among both.
[0035] In addition, it is thought that it happens in order that the surface tension which is going to become a globular form when solder is attached to a metal, while the operation which is going to exist in a stable configuration by near the center of opening for solder bump formation with the fluidity to which self has [solder] a self-alignment operation at the time of reflow processing is said and, as for this operation, solder is crawled by the solder resist layer may work strongly. Though location gap has occurred to both in front of a reflow in case the above-mentioned external substrate is connected the above-mentioned multilayer printed wiring board top through the above-mentioned solder bump when this self-alignment operation is used, the above-mentioned external substrate can move at the time of a reflow, and this external substrate can be attached in the exact location on the above-mentioned multilayer printed wiring board.
[0036] An example of the operation gestalt of the multilayer printed wiring board of the first this invention which consists of the above-mentioned configuration hereafter is explained referring to a drawing. Drawing 1 is the sectional view showing typically 1 operation gestalt of the multilayer printed wiring board of the first this invention.
[0037] it is shown in drawing 1 — as — a multilayer printed wiring board 100 — both sides of a substrate 121 — a conductor — the conductor with which laminating formation was carried out and the substrate 121 of the resin insulating layer [a circuit 124 and] 122 between layers was pinched — the conductor which sandwiched the resin insulating layer 122 between layers between circuits — between circuits, the through hole 129 and the Bahia hall 127 connect electrically, and the solder resist layer 134 is formed in the outermost layer, respectively.

[0038] moreover — substrate 121 front face — the conductor of the lowest layer — the opening 138 (138a, 138b) for optical paths is formed [the part in which optical waveguide 150 (150a, 150b) is formed in through the elastic material layer 152 with the circuit 124, and the optical-path conversion mirror 151 (151a, 151b) at the tip of optical waveguide 150 was formed] perpendicularly at the substrate 121. Moreover, this opening 138 for optical paths is constituted by the opening. In addition, one side is the optical waveguide for light-receiving, and another side of optical waveguides 150a and 150b is the optical waveguide for luminescence.
[0039] In the multilayer printed wiring board 100 which consists of such a configuration, the lightwave signal sent from the outside through an optical fiber (not shown) etc. will be introduced into optical waveguide 150a, and will be sent to a photo detector (not shown) etc. through optical-path conversion mirror 151a and opening 138a for optical paths. moreover, the lightwave signal sent out from the light emitting device (not shown) etc. is conversion mirror [optical] 151b minded from opening 138for optical paths b, is introduced into optical waveguide 150b, is sent to the photo detector of another substrate for IC chip mounting, and is changed into an electrical signal, or is delivery outside through an optical fiber (not shown) etc. — it will be carried out.
[0040] Moreover, when external substrates (not shown), such as a substrate for IC chip mounting, are connected

through the solder bump 137, a multilayer printed wiring board 100 and an external substrate can be connected electrically, and further, when the optical element is mounted in this external substrate, a lightwave signal and an electrical signal can be transmitted between a multilayer printed wiring board 100 and an external substrate.
[0041] In addition, the multilayer printed wiring board of the first this invention which consists of such a configuration can be used as a package substrate, a mother board, a daughter board, etc. by forming opening for mounting the substrate for IC chip mounting, and surface mount mold electronic parts in a solder resist layer, or choosing no, whether BGA and PGA are arranged again, no, etc. suitably.
[0042] Especially in the multilayer printed wiring board which has the optical waveguide of such a configuration, in case an optical-path conversion mirror is formed in optical waveguide at the time of optical waveguide formation, the stress concerning a substrate can be eased. Moreover, when carrying out by sticking the optical waveguide which fabricated formation of optical waveguide in the shape of a film beforehand, the stress applied to optical waveguide at the time of attachment can be eased. In addition, the approach of forming optical waveguide and the approach of forming an optical-path conversion mirror in optical waveguide are explained in full detail, in case the manufacture approach of a multilayer printed wiring board is explained later.
[0043] Next, how to manufacture the multilayer printed wiring board of the first this invention is explained.
(1) an insulating substrate — a start ingredient — carrying out — first — this insulating substrate top — a conductor — form a circuit. As the above-mentioned insulating substrate, a glass epoxy group plate, a polyester substrate, a polyimide substrate, a bismaleimide-triazine (BT) resin substrate, a thermosetting polyphenylene ether substrate, copper clad laminate, a RCC substrate, etc. are mentioned, for example. Moreover, ceramic substrates, such as an alumimium nitride substrate, and a silicon substrate may be used. the above — a conductor — a circuit can be formed by performing etching processing, after forming a solid conductor layer in the front face of for example, the above-mentioned insulating substrate by nonelectrolytic plating processing etc. Moreover, you may form by performing etching processing to copper clad laminate or a RCC substrate.
[0044] moreover, the thing for which etching processing is performed — a conductor — forming an electroplating layer in the plating-resist agenesis section, and removing the conductor layer under plating resist and this plating resist after that, after replacing with the approach of forming a circuit and forming plating resist on a solid conductor layer — a conductor — the approach of forming a circuit — using — a conductor — a circuit may be formed.
[0045] moreover, the conductor whose above-mentioned insulating substrate was pinched — in making connection between circuits by the through hole, after using a drill, laser, etc. for example, for the above-mentioned insulating substrate and forming a through tube, the through hole is formed by performing nonelectrolytic plating processing etc. In addition, the diameter of the above-mentioned through tube is usually 100-300 micrometers. Moreover, when a through hole is formed, it is desirable to be filled up with a resin filler in this through hole.
[0046] (2) next, the need — responding — a conductor — perform roughening formation processing on the surface of a circuit. as the above-mentioned roughening formation processing — melanism (oxidization) — the etching processing using the etching reagent containing - reduction processing, the second copper complex, and an organic-acid salt etc., processing by the Cu-nickel-P needlelike alloy plating, etc. can be mentioned. the case where a roughening side is formed here — the average roughness of this roughening side — usually — 0.1-5 micrometers — desirable — a conductor — the adhesion of a circuit and the resin insulating layer between layers, and a conductor — when the effect to the electrical signal transmission ability of a circuit etc. is taken into consideration, 2-4 micrometers is more desirable. In addition, before this roughening formation processing is filled up with a resin filler in a through hole, it may be performed, and it may form a roughening side also in the wall surface of a through hole. It is because the adhesion of a through hole and a resin filler improves.
[0047] (3) next, the conductor on a substrate — form an elastic material layer and optical waveguide in the circuit agenesis section. Formation of the above-mentioned elastic material layer can be performed using the approach of sticking the elastic material of the shape of a film judged in desired magnitude for example beforehand, the approach of forming an elastic material layer only in a position by exposure and the development, after applying the resin constituent containing the ingredient resin of an elastic material layer using a roll coater, a curtain coating machine, etc., etc. Moreover, after applying a resin constituent by the above-mentioned approach, an elastic material layer may be formed in a position by performing the etching method, the resist forming method, etc.
[0048] Subsequently, optical waveguide is formed on the above-mentioned elastic material layer. Formation of optical waveguide can use for example, a selective polymerization method, the method of using reactive ion etching and photolithography, the direct exposing method, the approach using injection molding, the photograph breeching method, the approach that combined these.
[0049] Spreading membrane formation of the resin constituent for optical waveguides used as the undershirt

clad section is specifically, for example, first, carried out on an elastic material layer using a spin coater etc., heat hardening of this is carried out, after that, spreading membrane formation of the resin constituent for optical waveguides which serves as a core layer on the undershirt clad section is carried out, and heat hardening of this is carried out. Next, a resist is applied on the surface of a core layer, a resist pattern is formed with photolithography, and patterning is carried out to the configuration of the core section by RIE (reactive ion etching) etc. Furthermore, optical waveguide can be formed by carrying out spreading membrane formation of the resin constituent for optical waveguides used as the exaggerated clad section, and carrying out heat hardening of this on the undershirt clad section (a core section top being included), etc. Here, an approach, printing, etc. which use a curtain coating machine and a roll coater may perform spreading membrane formation of the resin constituent for optical waveguides. In addition, in addition to the above-mentioned polymer ingredient and the above-mentioned particle, as the above-mentioned resin constituent for optical waveguides, what blended the curing agent, the reaction stabilizer, the solvent, etc. is mentioned if needed, for example.
[0050] Here, spreading of the resin constituent for optical waveguides may be performed at once, respectively, and you may carry out by dividing into multiple times. In addition, which is chosen should just choose suitably in consideration of the thickness of the clad section and the core section etc.
[0051] Moreover, a non-hardened resin constituent may be replaced with the approach of carrying out spreading membrane formation, and the approach of sticking the film (film-like optical waveguide) which consists of a resin constituent for optical waveguides formed beforehand may be used. The resin constituent for optical waveguides is specifically, for example, beforehand, used on a base material, a mold releasing film, etc., film-like optical waveguide is produced, and it forms by sticking this on an elastic material layer. In this case, before sticking film-like optical waveguide on a substrate (on an elastic material layer), an optical-path conversion mirror may be formed beforehand. In addition, formation of the above-mentioned optical-path conversion mirror can be performed by the approach using the diamond saw mentioned later, and the same approach.
[0052] In addition, whether formation of an optical-path conversion mirror is performed after forming optical waveguide on a substrate, or it carries out, before sticking film-like optical waveguide on a substrate should just choose suitably in consideration of the configuration of an optical-path conversion mirror etc. Specifically with the multilayer printed wiring board shown in drawing 1 R> 1, the optical-path conversion mirror 151 (151a, 151b) prepared in optical waveguide 150 (150a, 150b) has an inclination where the base of optical waveguide 150 becomes larger than a top face. After such an optical-path conversion mirror of a configuration forms optical waveguide on a substrate (on an elastic material layer), it can be easily formed by machining using a diamond saw. Therefore, what is necessary is just to form such an optical-path conversion mirror of a configuration, after forming optical waveguide on a substrate (on an elastic material layer).
[0053] However, what is necessary is not to necessarily limit the configuration of this optical-path conversion mirror to a configuration as shown in drawing 1 , and just to choose it suitably in consideration of the structure of a multilayer printed wiring board etc. in the multilayer printed wiring board of the first this invention, when forming the optical waveguide which has an optical-path conversion mirror. Like the optical waveguide 1150 (1150a, 1150b) which follows, for example, is shown in drawing 8 , the optical-path conversion mirror 1151 (1151a, 1151b) may be formed in a configuration to which the top face of optical waveguide 1150 becomes larger than a base. In addition, drawing 8 is the sectional view showing typically 1 another operation gestalt of the multilayer printed wiring board of the 1st this invention, it is only that the configuration (configuration of the optical-path conversion mirrors 1151a and 1151b) of optical waveguide 1150 differs from the multilayer printed wiring board 100 shown in drawing 1 , and the other configurations of the multilayer printed wiring board 1000 shown in drawing 8 are the same as that of a multilayer printed wiring board 100.
[0054] As shown in drawing 8 , when forming the optical waveguide which has the optical-path conversion mirror of a configuration to which the top face of optical waveguide becomes larger than a base, it is difficult for such an optical-path conversion mirror to form, after forming optical waveguide on a substrate (on an elastic material layer). Therefore, formation of the optical waveguide which has such an optical-path conversion mirror is performed by sticking the optical waveguide of the shape of a film which formed the optical-path conversion mirror beforehand on a substrate (on an elastic material layer). In manufacture of the multilayer printed wiring board of the first this invention, since the optical waveguide of the shape of this film will be stuck on the elastic material layer formed in the substrate when using the approach of sticking film-like optical waveguide in this way, the stress applied to optical waveguide at the time of attachment can be eased, and generating of a blemish, a crack, etc. can be prevented.
[0055] Moreover, when forming optical waveguide using the approach of sticking a film, on a substrate, an elastic material layer and optical waveguide may be formed using the approach of sticking the film which consists of two-layer [which an elastic material layer and optical waveguide piled up beforehand] by thermocompression bonding etc. The stress applied to optical waveguide also in this case can be eased. in addition, the formation

process of optical waveguide — a substrate top — a conductor — you may carry out, before forming a circuit.

[0056] Moreover, when forming an optical-path conversion mirror in the above-mentioned optical waveguide, formation of this optical-path conversion mirror may be performed after forming optical waveguide on a substrate (on an elastic material layer). It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose tip is 90 degrees of V types etc. can be used. Thus, since the stress concerning a substrate can be eased when forming the mirror for optical-path conversion in the optical waveguide formed on the elastic material layer by the above-mentioned approach, it can prevent that a crack etc. occurs in a substrate.

[0057] (4) next, optical waveguide and a conductor — form the resin layer which forms the resin layer which is not hardened [which some of thermosetting resin photopolymers, and thermosetting resin become from the acrylic-ized resin, these and thermoplastics, and the included resin complex] on the substrate in which the circuit was formed, or consists of thermoplastics. The resin layer which is not hardened [above-mentioned] can be formed by applying non-hardened resin by the roll coater, a curtain coating machine, etc., or carrying out thermocompression bonding of the resin film non-hardened (semi-hardening). Moreover, the resin layer which consists of the above-mentioned thermoplastics can be formed by carrying out thermocompression bonding of the resin Plastic solid fabricated on the film.

[0058] In these, the approach of carrying out thermocompression bonding of the resin film non-hardened (semi-hardening) is desirable, and sticking by pressure of a resin film can be performed for example, using a vacuum laminator etc. Moreover, although what is necessary is not to limit especially sticking-by-pressure conditions, but just to choose suitably in consideration of the presentation of a resin film etc., it is usually desirable to carry out on a pressure 0.25 - 1.0MPa, the temperature of 40-70 degrees C, the degree of vacuum of 13-1300Pa, and about [time amount 10-120 second] conditions.

[0059] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyester resin, a bismaleimide resin, polyolefine system resin, polyphenylene ether resin, polyphenylene resin, a fluororesin, etc. are mentioned, for example. As an example of the above-mentioned epoxy resin, novolak mold epoxy resins, such as a phenol novolak mold and a cresol novolak mold, the cycloaliphatic epoxy resin which carried out dicyclopentadiene conversion are mentioned, for example.

[0060] As the above-mentioned photopolymer, acrylic resin etc. is mentioned, for example. Moreover, the thing to which the heat-curing radical, and the methacrylic acid and acrylic acid of the above-mentioned thermosetting resin were made to acrylic--ization-react as resin which acrylic-ized some above-mentioned thermosetting resin for example, is mentioned.

[0061] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone (PES), polysulfone (PSF), polyphenylene sulfone (PPS) polyphenylene sulfide (PPES), polyphenylene ether (PPE) polyether imide (PI), etc. are mentioned, for example.

[0062] Moreover, as the above-mentioned resin complex, especially if thermosetting resin, a photopolymer (the resin which acrylic-ized some thermosetting resin is also included), and thermoplastics are included, it will not be limited, but as a concrete combination of thermosetting resin and thermoplastics, phenol resin / polyether sulfone, polyimide resin/polysulfone, an epoxy resin / polyether sulfone, an epoxy resin/phenoxy resin, etc. are mentioned, for example. Moreover, as a concrete combination of a photopolymer and thermoplastics, acrylic resin/phenoxy resin, an epoxy resin / polyether sulfone etc. that acrylic-ized a part of epoxy group are mentioned, for example.

[0063] Moreover, as for the rate of a compounding ratio of thermosetting resin and the photopolymer in the above-mentioned resin complex, and thermoplastics, thermosetting resin or a photopolymer / thermoplastics =95 / 5 - 50/50 are desirable. It is because a high toughness value is securable, without spoiling thermal resistance.

[0064] Moreover, the above-mentioned resin layer may consist of resin layers from which it differs more than two-layer. It is that a lower layer is formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =50/50, and the upper layer is specifically formed from thermosetting resin or the resin complex of a photopolymer / thermoplastics =90/10 etc. While securing the adhesion which was excellent with the insulating substrate etc. by making it such a configuration, the formation ease at the time of forming opening for the Bahia halls etc. at a back process is securable.

[0065] Moreover, the above-mentioned resin layer may be formed using the resin constituent for roughening side formation. The matter of fusibility is distributed to the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer into the heat-resistant-resin matrix which is not hardened [poorly soluble] to the roughening liquid which serves as the above-mentioned resin constituent for roughening side formation from at least one sort chosen from an acid, alkali, and an oxidizer. In addition, when the same time

amount immersion is carried out, the word of the above "poor solubility" and "fusibility" says relatively what has an early dissolution rate as "fusibility" to the same roughening liquid for convenience, and calls "poor solubility" relatively what has a late dissolution rate to it for convenience.
[0066] In case the above-mentioned roughening liquid is used for the resin insulating layer between layers and a roughening side is formed as the above-mentioned heat-resistant-resin matrix, what can hold the configuration of a roughening side is desirable, for example, thermosetting resin, thermoplastics, these complex, etc. are mentioned. Moreover, by using a photopolymer, exposure and a development may be used for the resin insulating layer between layers, and opening for the Bahia halls may be formed.
[0067] As the above-mentioned thermosetting resin, an epoxy resin, phenol resin, polyimide resin, polyolefin resin, a fluororesin, etc. are mentioned, for example. Moreover, when sensitization-izing the above-mentioned thermosetting resin, a heat-curing radical is made to acrylic(meta)—ization-react using a methacrylic acid, an acrylic acid, etc.
[0068] As the above-mentioned epoxy resin, a cresol novolak mold epoxy resin, the bisphenol A mold epoxy resin, a bisphenol female mold epoxy resin, a phenol novolak mold epoxy resin, an alkylphenol novolak mold epoxy resin, a biphenol female mold epoxy resin, a naphthalene mold epoxy resin, a dicyclopentadiene mold epoxy resin, the epoxidation object of the condensate of phenols and the aromatic aldehyde which has a phenolic hydroxyl group, triglycidyl isocyanurate, cycloaliphatic epoxy resin, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts. Thereby, it excels in thermal resistance etc.
[0069] As the above-mentioned thermoplastics, phenoxy resin, polyether sulfone, polysulfone, polyphenylene sulfone, polyphenylene sulfide, a polyphenyl ether, polyether imide, etc. are mentioned, for example. These may be used independently and may be used together two or more sorts.
[0070] As matter of fusibility, an inorganic particle, a resin particle, metal particles, a rubber particle, liquid phase resin, liquid phase rubber, etc. are mentioned to the roughening liquid which consists of at least one sort chosen from the above-mentioned acid, alkali, and an oxidizer, for example, and an inorganic particle, a resin particle, and metal particles are desirable in these. Moreover, these may be used independently and may be used together two or more sorts.
[0071] As the above-mentioned inorganic particle, what consists of titanium compounds, such as silicon compounds, such as magnesium compounds, such as potassium compounds, such as lime compounds, such as aluminium compounds, such as an alumina and an aluminum hydroxide, a calcium carbonate, and a calcium hydroxide, and potassium carbonate, a magnesia, a dolomite, basic magnesium carbonate, and talc, a silica, and a zeolite, and a titania, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts. Dissolution removal of the above-mentioned alumina particle can be carried out by fluoric acid, and dissolution removal of the calcium carbonate can be carried out with a hydrochloric acid. Moreover, dissolution removal of a sodium content silica or the dolomite can be carried out in an alkali water solution.
[0072] As the above-mentioned resin particle, what consists of thermosetting resin, thermoplastics, etc. is mentioned, for example. When immersed in the roughening liquid which consists of at least one sort chosen from an acid, alkali, and an oxidizer It will not be limited especially if a dissolution rate is earlier than the above-mentioned heat-resistant-resin matrix. Specifically For example, what consists of amino resin (melamine resin, a urea-resin, guanamine resin, etc.), an epoxy resin, phenol resin, phenoxy resin, polyimide resin, polyphenylene resin, polyolefin resin, a fluororesin, bismaleimide-triazine resin, etc. is mentioned. These may be used independently and may be used together two or more sorts. In addition, the above-mentioned resin particle needs to carry out hardening processing beforehand. It is because the above-mentioned resin particle dissolves in the solvent in which a resin matrix is dissolved, so homogeneity will be mixed and dissolution removal only of the resin particle can be alternatively carried out neither with an acid nor an oxidizer, unless it makes it harden.
[0073] As the above-mentioned metal particles, what consists of gold, silver, copper, tin, zinc, stainless steel, aluminum, nickel, iron, lead, etc. is mentioned, for example. These may be used independently and may be used together two or more sorts. Moreover, the surface may be covered with resin etc. in order that the above-mentioned metal particles may secure insulation.
[0074] When two or more sorts are mixed and it uses the matter of the above-mentioned fusibility, as a combination of the matter of two sorts of fusibility to mix, the combination of a resin particle and an inorganic particle is desirable. the resin insulating layer between layers which adjustment of thermal expansion tends to plan them between poorly soluble resin, and they become from the resin constituent for roughening side formation while both of conductivity can be hurt low and can secure the insulation of the resin insulating layer between layers — a crack — not generating — the resin insulating layer between layers, and a conductor — it is because exfoliation does not occur between circuits.
[0075] It is desirable to use an organic acid in these as an acid used as the above-mentioned roughening liquid,

for example, although organic acids, such as a phosphoric acid, a hydrochloric acid, a sulfuric acid, a nitric acid, and formic acid, an acetic acid, etc. are mentioned. It is because it is hard to make the metallic conductor layer exposed from the Bahia hall corrode when roughening processing is carried out. Moreover, a sodium hydroxide, a potassium hydroxide, etc. are mentioned as the above-mentioned alkali. As the above-mentioned oxidizer, it is desirable to, use the water solution of a chromic acid, chromate acid mixture, and alkaline permanganates (potassium permanganate etc.) etc. for example.

[0076] The mean particle diameter of the matter of the above-mentioned fusibility has desirable 10 micrometers or less. Moreover, big coarse grain and mean particle diameter may use it combining a small particle relatively relatively [mean particle diameter / the mean particle diameter of 2 micrometers or less]. That is, it is combining the matter of the fusibility whose mean particle diameter's is 0.1-0.8 micrometers, and the matter of the fusibility whose mean particle diameter's is 0.8-2.0 micrometers etc.

[0077] Thus, when big coarse grain and mean particle diameter combine a small particle relatively relatively [particle / average], the dissolution residue of the nonelectrolytic plating film can be lost, the amount of palladium catalysts under plating resist can be lessened, and a still shallower and complicated roughening side can be formed. Furthermore, by forming a complicated roughening side, even if the irregularity of a roughening side is small, the practical Peel reinforcement is maintainable.

[0078] (5) Next, in forming the resin insulating layer between layers using thermosetting resin and resin complex as the ingredient, while performing hardening processing to a non-hardened resin insulating layer, form opening for the Bahia halls and consider as the resin insulating layer between layers. Moreover, at this process, a through tube may be formed if needed. As for the above-mentioned opening for the Bahia halls, forming by the lasing is desirable. Moreover, when a photopolymer is used as an ingredient of the resin insulating layer between layers, you may form by the exposure development.

[0079] Moreover, in forming the resin insulating layer between layers using thermoplastics as the ingredient, opening for the Bahia halls is formed in the resin layer which consists of thermoplastics, and it considers as the resin insulating layer between layers. In this case, opening for the Bahia halls can be formed by giving the lasing. Moreover, what is necessary is just to form this through tube by drilling, the lasing, etc., when forming a through tube at this process.

[0080] As laser used for the above-mentioned lasing, carbon dioxide gas laser, ultraviolet laser, excimer laser, etc. are mentioned, for example. In these, excimer laser and the carbon dioxide gas laser of a short pulse are desirable.

[0081] Moreover, it is desirable also in excimer laser to use the excimer laser of a hologram method. A hologram method is a method which irradiates a laser beam through a hologram, a condenser lens, a laser mask, an imprint lens, etc. at the specified substance, and much openings can be once formed efficiently by laser radiation by using this method.

[0082] Moreover, when using carbon dioxide gas laser, as for the pulse separation, it is desirable that they are 10-4 - 10 to 8 seconds. Moreover, as for the time amount which irradiates the laser for forming opening, it is desirable that it is 10 - 500 microseconds. Moreover, much openings for the Bahia halls can be formed at once by irradiating a laser beam through an optical-system lens and a mask. By minding an optical-system lens and a mask, it is the same reinforcement and is because exposure reinforcement can irradiate the same laser beam at two or more parts. Thus, after forming opening for the Bahia halls, DESUMIA processing may be performed if needed.

[0083] (6) Next, form a thin film conductor layer in the front face of the resin insulating layer between layers including the wall of opening for the Bahia halls. The above-mentioned thin film conductor layer can be formed by approaches, such as nonelectrolytic plating and sputtering.

[0084] As the quality of the material of the above-mentioned thin film conductor layer, copper, nickel, tin, zinc, cobalt, a thallium, lead, etc. are mentioned, for example. In these, what consists of the copper from a point, copper, and nickel which are excellent in an electrical property, economical efficiency, etc. is desirable. Moreover, as thickness of the above-mentioned thin film conductor layer, when forming a thin film conductor layer with nonelectrolytic plating, 0.3-2.0 micrometers is desirable and 0.6-1.2 micrometers is more desirable. Moreover, when forming by sputtering, 0.1-1.0 micrometers is desirable. In addition, in forming a thin film conductor layer with nonelectrolytic plating, it gives the catalyst beforehand to the front face of the resin insulating layer between layers. As the above-mentioned catalyst, a palladium chloride etc. is mentioned, for example.

[0085] Moreover, a roughening side may be formed in the front face of the resin insulating layer between layers before forming the above-mentioned thin film conductor layer. By forming a roughening side, the adhesion of the resin insulating layer between layers and a thin film conductor layer can be raised.

[0086] Moreover, when a through tube is formed at the process of the above (5), in case a thin film conductor

layer is formed on the resin insulating layer between layers, it is good also as a through hole by forming a thin film conductor layer also in the wall surface of a through tube.
[0087] (7) Subsequently, form plating resist on the substrate with which the thin film conductor layer was formed in the front face. After the above-mentioned plating resist sticks for example, a photosensitive dry film, it can carry out adhesion arrangement of the photo mask which consists of a glass substrate with which the plating resist pattern was drawn, and can form it by performing an exposure development.
[0088] (8) After that, perform electrolysis plating by making a thin film conductor layer into a plating bar, and form an electrolysis plating layer in the above-mentioned plating-resist agenesis section. As the above-mentioned electrolysis plating, copper plating is desirable. Moreover, the thickness of the above-mentioned electrolysis plating layer has desirable 5-20 micrometers. then, the thing for which the nonelectrolytic plating film and thin film conductor layer under the above-mentioned plating resist and this plating resist are removed -- a conductor -- a circuit (the Bahia hall is included) can be formed. What is necessary is just to perform removal of the above-mentioned thin film conductor layer using etching reagents, such as mixed liquor of a sulfuric acid and a hydrogen peroxide, sodium persulfate, ammonium persulfate, a ferric chloride, and a cupric chloride, that what is necessary is just to perform removal of the above-mentioned plating resist for example, using an alkali water solution etc. moreover, the above -- a conductor -- after forming a circuit, the catalyst on the resin insulating layer between layers may be removed using an acid or an oxidizer if needed. It is because the fall of an electrical property can be prevented. passing through the process of such (6) - (8) -- a conductor -- a circuit can be formed.
[0089] in addition -- although the approach of above-mentioned (6) - (8) is a semiadditive process -- this approach -- replacing with -- a fully-additive process -- a conductor -- a circuit may be formed. the conductor which used the dry film for the part on this electrolysis plating layer, formed etching resist, removed an etching-resist agenesis subordinate's electrolysis plating layer and thin film conductor layer by etching after that, and became independent by exfoliating etching resist further after specifically forming an electrolysis plating layer the whole surface on the thin film conductor layer formed by the same approach as the above (6) -- a circuit may be formed.
[0090] the conductor of others [additive process / such], such as a subtractive process, -- the manufacture approach of a circuit -- comparing -- since etching precision is high -- a more detailed conductor -- while being able to form a circuit -- a conductor -- the degree of freedom of a design of a circuit improves. in addition, the above -- a conductor -- a circuit may be formed by the build up method.
[0091] Moreover, when a through hole is formed in the above (5) and the process of (6), it may be filled up with a resin filler in this through hole. Moreover, when filled up with a resin filler in a through hole, a wrap lid plating layer may be formed for the surface section of a resin filler layer by performing nonelectrolytic plating if needed.
[0092] (9) next, the thing for which roughening processing is performed on the front face of this lid plating layer, and the process of (4) - (8) is further repeated if needed when a lid plating layer is formed -- the both sides -- the resin insulating layer between layers, and a conductor -- carry out laminating formation of the circuit. In addition, a through hole may be formed and it is not necessary to form at this process.
[0093] (10) Next, form the solder resist layer of the outermost layer if needed. The above-mentioned solder resist layer can be formed using the solder resist constituent which consists of for example, polyphenylene ether resin, polyolefin resin, a fluororesin, thermoplastic elastomer, an epoxy resin, polyimide resin, etc.
[0094] moreover, as solder resist constituents other than the above For example, the acrylate (meta) of a novolak mold epoxy resin, an imidazole curing agent, 2 functionality (meta) acrylic ester monomer, the polymer of with a molecular weight of about 500 to 5000 acrylic ester (meta), The fluid of the shape of a paste containing photosensitive monomers, such as thermosetting resin which consists of a bisphenol mold epoxy resin etc., and a multiple-valued acrylic monomer, a glycol ether system solvent, etc. is mentioned, and, as for the viscosity, it is desirable to be adjusted to 1 - 10 Pa-s at 25 degrees C. By forming the above-mentioned solder resist layer in the outermost layer, the above-mentioned optical waveguide can be protected from damage, heat, etc.
[0095] (11) Next, form opening for mounting the substrate for IC chip mounting, and various surface mount mold electronic parts in the above-mentioned solder resist layer if needed. Specifically, it can carry out using the approach of forming opening for the Bahia halls, and the same approach, i.e., an exposure development and the asing. in addition, such opening may be formed only in the solder resist layer of one side, and a double-sided solder resist layer may boil it, respectively, and it may be formed. Moreover, in case a solder resist layer is formed, the solder resist layer which has opening for mounting the substrate for IC chip mounting etc. may be formed by producing the resin film which has opening in a desired location, and sticking this resin film on it beforehand. Moreover, the diameter of opening of opening for mounting the above-mentioned substrate for IC chip mounting has desirable 500-1000 micrometers.
[0096] (12) next, the conductor exposed by forming opening for mounting the above-mentioned substrate for IC

chip mounting etc. — if needed, a circuit part is covered with corrosion-resistant metals, such as nickel, palladium, gold, silver, and platinum, and let it be a pad for surface mounts. In these, it is desirable to form an enveloping layer with metals, such as nickel-gold, nickel-silver, nickel-palladium, and nickel-palladium-gold. Although the above-mentioned enveloping layer can be formed according to plating, vacuum evaporationo, electrodeposition, etc., in these, it is desirable to form with plating from the point of excelling in the homogeneity of an enveloping layer.

[0097] (13) Next, form in one side of a substrate opening for optical paths which penetrates a solder resist layer and the resin insulating layer between layers and which was open for free passage. The lasing etc. performs formation of the above-mentioned opening for optical paths. the above-mentioned lasing — the same thing as the laser which is and is used in formation of the above-mentioned opening for the Bahia halls as laser to be used etc. is mentioned. In this case, it is desirable to use the laser of the wavelength in which the above-mentioned optical waveguide does not have absorption as the above-mentioned laser. It is because there are few possibilities of damaging the above-mentioned optical waveguide front face when forming the above-mentioned opening for optical paths. moreover, the formation location of the above-mentioned opening for optical paths will be limited especially if it is the location which can transmit the lightwave signal from optical waveguide, and the signal to optical waveguide — not having — a conductor — what is necessary is just to choose suitably in consideration of the design of a circuit etc.

[0098] The diameter of opening of the above-mentioned opening for optical paths has desirable 100-500 micrometers. Moreover, especially the configuration is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned. In addition, although what is necessary is just to perform it after it forms a solder resist layer as mentioned above, after forming the resin insulating layer between layers, and formation of opening for optical paths forms opening for optical paths once depending on the case and forms a solder resist layer, it forms opening which was open for free passage again to opening for optical paths prepared in the resin insulating layer between layers, and is good also as opening for optical paths. It is because it is sometimes difficult to form opening for optical paths by the lasing once depending on the thickness of the resin insulating layer between layers, or a solder resist layer. Moreover, when forming opening in 2 steps, opening formed in a solder resist layer may be formed by the exposure development.

[0099] (14) Next, form a solder bump by carrying out a reflow after filling up the above-mentioned pad for surface mounts with soldering paste (for example, Sn/Ag=96.5/3.5) through the mask with which opening was formed in the part equivalent to the above-mentioned pad for surface mounts if needed. Moreover, it is good also as PGA (Pin Grid Array) or BGA (Ball Grid Array) by using electroconductive glue etc., arranging a pin or forming a solder ball in an external substrate connection side in the solder resist layer of a field and the opposite side which forms optical waveguide, if needed. Although not limited especially as the above-mentioned pin, the pin of T mold is desirable. Moreover, as the quality of the material, covar, 42 alloys, etc. are mentioned, for example.

[0100] Moreover, after being filled up with soldering paste, before carrying out a reflow, the substrate for IC chip mounting and other surface mount mold electronic parts may be carried, and you may solder by carrying out a reflow after that here. In addition, although especially the sequence of carrying the substrate for IC chip mounting and surface mount mold electronic parts in this case (soldering) is not limited, it is desirable to carry behind what has many numbers of connection terminals.

[0101] In addition, it is not necessary to form a solder bump, and PGA and BGA at this process. The substrate for IC chip mounting and surface mount mold electronic parts can be mounted in a multilayer printed wiring board by connecting the bump formed in BGA and surface mount mold electronic parts of the substrate for IC chip mounting, and the above-mentioned pad for surface mounts. By passing through such a process, the multilayer printed wiring board of the first this invention can be manufactured.

[0102] Next, the multilayer printed wiring board of the second this invention is explained. the multilayer printed wiring board of the second this invention — both sides of a substrate — a conductor — while laminating formation of a circuit and the resin insulating layer between layers is carried out, it is the multilayer printed wiring board with which optical waveguide was formed on the resin insulating layer between layers of the outermost layer, and is characterized by forming the elastic material layer between the resin insulating layer between layers of the above-mentioned outermost layer, and the above-mentioned optical waveguide.

[0103] In the multilayer printed wiring board of the second this invention, since optical waveguide is formed through the elastic material layer on the resin insulating layer between layers of the outermost layer, at the time of optical waveguide formation, in case an optical-path conversion mirror is especially formed in optical waveguide, the stress concerning the resin insulating layer between layers can be eased, and the crack resulting from this stress etc. can prevent generating in a substrate. Therefore, the fall of the dependability of a multilayer

printed wiring board is not caused by the crack generated in the resin insulating layer between layers. In addition, it can prevent that can ease the stress concerning optical waveguide and a blemish, a crack, etc. occur in optical waveguide by the above-mentioned elastic material layer at the time of optical waveguide formation in sticking the optical waveguide of the shape of a film which formed the optical-path conversion mirror beforehand.

[0104] moreover — the above-mentioned multilayer printed wiring board — a conductor — since both a lightwave signal and an electrical signal can be transmitted since a circuit and optical waveguide are formed, and optical waveguide is built in in the multilayer printed wiring board, it can contribute to the miniaturization of the terminal equipment for optical communication.

[0105] The multilayer printed wiring board of the second this invention is a multilayer printed wiring board with which optical waveguide was formed on the resin insulating layer between layers of the outermost layer, and the elastic material layer is formed between the above-mentioned resin insulating layer between layers, and the above-mentioned optical waveguide. As the above-mentioned elastic material layer, like the elastic material layer of the multilayer printed wiring board of the first this invention, a being [the elastic modulus / 2.5x103 or less MPas] thing is desirable, and what is 1.0-1.0x103MPa is more desirable. If the above-mentioned elastic modulus exceeds 2.5x103MPa, the stress applied to the resin insulating layer between layers at the time of optical waveguide formation cannot fully be eased. It adds to the ability not to prevent that a crack etc. occurs in the resin insulating layer between layers. It is because the stress which results from the difference of the coefficient of thermal expansion of optical waveguide, and the resin insulating layer between layers and a solder resist layer, and is applied to optical waveguide cannot fully be eased but a crack may occur in optical waveguide. Furthermore, when performing formation of optical waveguide by sticking film-like optical waveguide, stress concerning optical waveguide cannot fully be eased, but a blemish, a crack, etc. may occur in optical waveguide. Moreover, what consists of the polyolefine system resin and/or polyimide system resin which have the elastic modulus of the above-mentioned range as the concrete quality of the material of the above-mentioned elastic material layer is desirable.

[0106] The multilayer printed wiring board of the second this invention begins the elastic material layer described above although the formation location of optical waveguide and an elastic material layer differed from the multilayer printed wiring board of the first this invention in respect of the resin insulating-layer top between layers of the outermost layer, and what is used for the multilayer printed wiring board of the first this invention, and the same thing are mentioned as the member which constitutes multilayer printed wiring boards, such as optical waveguide and a resin insulating layer between layers, or its ingredient. Therefore, explanation of the member which constitutes the multilayer printed wiring board of the second this invention is given here to omit.

[0107] Next, an example of the operation gestalt of the multilayer printed wiring board of the second this invention is explained, referring to a drawing. Drawing 2 is the sectional view showing typically 1 operation gestalt of the multilayer printed wiring board of the second this invention.

[0108] it is shown in drawing 2 — as — a multilayer printed wiring board 200 — both sides of a substrate 221 — a conductor — the conductor with which laminating formation was carried out and the substrate 221 of the resin insulating layer [a circuit 224 and] 222 between layers was pinched — the conductor which sandwiched the resin insulating layer 222 between layers between circuits — between circuits, the through hole 229 and the Bahia hall 227 connect electrically, and the solder resist layer 234 is formed in the outermost layer, respectively.

[0109] Moreover, the opening 238 (238a, 238b) for optical paths is formed [the part in which optical waveguide 250 (250a 250b) is formed through the elastic material layer 252 on resin insulating-layer 222between layers a of the outermost layer, and the optical-path conversion mirror 251 (251a, 251b) at the tip of optical waveguide 250 was formed] perpendicularly at the substrate 221. Moreover, this opening 238 for optical paths is constituted by the opening. In addition, one side is the optical waveguide for light-receiving, and another side of optical waveguides 250a and 250b is the optical waveguide for luminescence.

[0110] In the multilayer printed wiring board 200 which consists of such a configuration, the lightwave signal sent from the outside through an optical fiber (not shown) etc. will be introduced into optical waveguide 250a, and will be sent to a photo detector (not shown) etc. through optical-path conversion mirror 251a and opening 238a for optical paths. moreover, the lightwave signal sent out from the light emitting device (not shown) etc. is conversion mirror [optical] 251b minded from opening 238for optical paths b, is introduced into optical waveguide 250b, is sent to the photo detector of another substrate for IC chip mounting, and is changed into an electrical signal, or is delivery outside through an optical fiber (not shown) etc. — it will be carried out.

[0111] Moreover, when external substrates (not shown), such as IC chip mounting substrate, are connected through the solder bump 237, a multilayer printed wiring board 200 and an external substrate can be connected electrically, and further, when the optical element is mounted in this external substrate, a lightwave signal and an

electrical signal can be transmitted between a multilayer printed wiring board 200 and an external substrate. In addition, the multilayer printed wiring board of the second this invention which consists of such a configuration can also be used as a package substrate, a mother board, a daughter board, etc. by forming opening for mounting the substrate for IC chip mounting etc. in a solder resist layer, or choosing no, whether BGA etc. is arranged again, no, etc. suitably.
[0112] Moreover, also in the multilayer printed wiring board of the second this invention, when the optical-path conversion mirror is formed in optical waveguide, the configuration of this optical-path conversion mirror may be a configuration to which it is not limited to a configuration to which the base of optical waveguide as shown in drawing 2 becomes larger than a top face, but the top face of optical waveguide becomes larger than a base.
[0113] Especially in the multilayer printed wiring board which has the optical waveguide of such a configuration, in case an optical-path conversion mirror is formed in optical waveguide at the time of optical waveguide formation, the stress concerning the resin insulating layer between layers can be eased. Moreover, when carrying out by sticking the optical waveguide which fabricated formation of optical waveguide in the shape of a film beforehand, the stress applied to optical waveguide at the time of attachment can be eased.
[0114] Next, how to manufacture the multilayer printed wiring board of the second this invention is explained. In addition, as the multilayer printed wiring board of the second this invention was mentioned above, compared with the multilayer printed wiring board of the first this invention, the formation locations of an elastic material layer and optical waveguide differ. Therefore, it is only that the formation process of an elastic material layer and optical waveguide differs from the manufacture approach of the multilayer printed wiring board of the first this invention, and the manufacture approach of the multilayer printed wiring board of the second this invention can perform other processes like the manufacture approach of the multilayer printed wiring board of the first this invention. Here, suppose that it explains focusing on the production process of an elastic material layer and optical waveguide, and all production processes are explained briefly.
[0115] (1) First, use an insulating substrate as a start ingredient and form a multilayer-interconnection plate like the process of (1) - (9) of the manufacture approach of the multilayer printed wiring board of the first this invention except not performing the process of (3) of the manufacture approach of the multilayer printed wiring board of the first this invention, i.e., the process which forms an elastic material layer and optical waveguide on a substrate.
[0116] (2) next, the conductor on the resin insulating layer between layers of the outermost layer — form an elastic material layer and optical waveguide in the circuit agenesis section. Formation of the above-mentioned elastic material layer can be performed using the approach of sticking the elastic material of the shape of a film judged in desired magnitude for example beforehand, the approach of forming an elastic material layer only in a position by exposure and the development, after applying the resin constituent containing the ingredient resin of an elastic material layer using a roll coater, a curtain coating machine, etc., etc. Moreover, after applying a resin constituent by the above-mentioned approach, an elastic material layer may be formed in a position by performing the etching method, the resist forming method, etc.
[0117] Subsequently, optical waveguide is formed on the above-mentioned elastic material layer. Formation of optical waveguide can use for example, a selective polymerization method, the method of using reactive ion etching and photolithography, the direct exposing method, the approach using injection molding, the photograph breeching method, the approach that combined these.
[0118] Spreading membrane formation of the resin constituent for optical waveguides used as the undershirt clad section is specifically, for example, first, carried out on an elastic material layer using a spin coater etc., heat hardening of this is carried out, after that, spreading membrane formation of the resin constituent for optical waveguides which serves as a core layer on the undershirt clad section is carried out, and heat hardening of this is carried out. Next, a resist is applied on the surface of a core layer, a resist pattern is formed with photolithography, and patterning is carried out to the configuration of the core section by RIE (reactive ion etching) etc. Furthermore, optical waveguide can be formed by carrying out spreading membrane formation of the resin constituent for optical waveguides used as the exaggerated clad section, and carrying out heat hardening of this on the undershirt clad section (a core section top being included), etc. Here, an approach, printing, etc. which use a curtain coating machine and a roll coater may perform spreading membrane formation of the resin constituent for optical waveguides. In addition, as the above-mentioned resin constituent for optical waveguides, what is used by the manufacture approach of the multilayer printed wiring board of the first this invention, the same thing, etc. are mentioned.
[0119] Here, spreading of the resin constituent for optical waveguides may be performed at once, respectively, and you may carry out by dividing into multiple times. In addition, which is chosen should just choose suitably in consideration of the thickness of the clad section and the core section etc.
[0120] Moreover, a non-hardened resin constituent may be replaced with the approach of carrying out spreading

membrane formation, and the approach of sticking the film (film-like optical waveguide) which consists of a resin constituent for optical waveguides formed beforehand may be used. The above-mentioned resin constituent for optical waveguides is specifically, for example, beforehand, used on a base material, a mold releasing film, etc., film-like optical waveguide is produced, and it forms by sticking this on an elastic material layer. In this case, before sticking film-like optical waveguide on a substrate (on an elastic material layer), an optical-path conversion mirror may be formed beforehand. Whether formation of an optical-path conversion mirror is performed after forming optical waveguide on a substrate, or it carries out, before sticking film-like optical waveguide on a substrate should just choose suitably in consideration of the configuration of an optical-path conversion mirror etc. In addition, formation of the above-mentioned optical-path conversion mirror can be performed by the approach using the diamond saw mentioned later, and the same approach. moreover, the formation process of optical waveguide — the resin insulating-layer top between layers — a conductor — you may carry out, before forming a circuit.

[0121] Moreover, an elastic material layer and optical waveguide may be formed on a substrate using the approach of sticking the film which consists of two-layer [which an elastic material layer and optical waveguide piled up beforehand] by thermocompression bonding etc.

[0122] Moreover, when forming an optical-path conversion mirror in the above-mentioned optical waveguide, formation of this optical-path conversion mirror may be performed after forming optical waveguide on a substrate (on an elastic material layer). It is not limited especially as an approach of forming the above-mentioned optical-path conversion mirror, but the well-known formation approach can be used conventionally. Specifically, machining with the diamond saw and cutter whose tip is 90 degrees of V types etc. can be used. Thus, since the stress concerning the resin insulating layer between layers can be eased when forming the mirror for optical-path conversion in the optical waveguide formed on the elastic material layer by the above-mentioned approach, it can prevent a crack etc. occurring in the resin insulating layer between layers.

[0123] (3) Next, like the process of (10) - (12) of the manufacture approach of the multilayer printed wiring board of the first this invention, on the resin insulating layer between layers in which optical waveguide was formed through the elastic material layer, form the solder resist layer which has opening for mounting the substrate for IC chip mounting etc., and form the pad for surface mounts further. In addition, the above-mentioned opening may be formed only in the solder resist layer of one side, and may be formed in a double-sided solder resist layer.

[0124] (4) Next, form opening for optical paths in the solder resist layer of one side. The lasing etc. performs formation of the above-mentioned opening for optical paths. the above-mentioned lasing — as the laser been and used — formation of the above-mentioned opening for the Bahia halls — it is and the same thing as the laser to be used etc. is mentioned. In this case, it is desirable to use the laser of the wavelength in which the above-mentioned optical waveguide does not have absorption as the above-mentioned laser. It is because there are few possibilities of damaging the above-mentioned optical waveguide front face when forming the above-mentioned opening for optical paths. moreover, the formation location of the above-mentioned opening for optical paths will be limited especially if it is the location which can transmit the lightwave signal from optical waveguide, and the signal to optical waveguide — not having — a conductor — what is necessary is just to choose suitably in consideration of the design of a circuit etc.

[0125] The diameter of opening of the above-mentioned opening for optical paths has desirable 100-500 micrometers. Moreover, especially the configuration is not limited, for example, the shape of the shape of cylindrical and an elliptic cylinder and the square pole, many prismatic forms, etc. are mentioned.

[0126] Moreover, opening for optical paths formed in the multilayer printed wiring board of the second this invention is opening which penetrates only the solder resist layer of one side. Therefore, in manufacture of the multilayer printed wiring board of the second this invention, when forming opening for optical paths, it replaces with the approach using the above-mentioned lasing, and in case opening for mounting the substrate for IC chip mounting etc. is formed by the exposure development at the process of the above (3), opening for optical paths may be formed in coincidence by the exposure development. While a routing counter is reducible, it is because there are more few possibilities of damaging optical waveguide compared with the lasing.

[0127] (5) Next, form a solder bump, and PGA and BGA like the process of (14) of the manufacture approach of the multilayer printed wiring board of the first this invention.

[0128] Moreover, when manufacturing the multilayer printed wiring board of the second this invention, after filling up soldering paste with this process, before carrying out a reflow, the substrate for IC chip mounting and other surface mount mold electronic parts may be carried, and you may solder by carrying out a reflow after that.

[0129] In addition, it is not necessary to form a solder bump, and PGA and BGA at this process. The substrate for IC chip mounting and surface mount mold electronic parts can be mounted in a multilayer printed wiring board by connecting the bump formed in BGA and surface mount mold electronic parts of the substrate for IC

chip mounting, and the above-mentioned pad for surface mounts. By passing through such a process, the multilayer printed wiring board of the second this invention can be manufactured.
[0130] In addition, especially in this specification, in case an optical-path conversion mirror is formed in optical waveguide at the time of optical waveguide formation It adds to it being hard to generate the crack resulting from the stress concerning the resin insulating layer between layers of a substrate or the outermost layer etc. in a substrate or the resin insulating layer between layers. Since the stress applied to optical waveguide by considering the difference of the coefficient of thermal expansion of optical waveguide, and a substrate and the resin insulating layer between layers as a cause can be eased, It is hard to generate the crack resulting from this stress etc. in optical waveguide. Further That the blemish which could ease the stress concerning optical waveguide also when film-like optical waveguide was stuck, and originated in this stress, and a crack occur in optical waveguide as a multilayer printed wiring board which can be prevented Although the multilayer printed wiring board with which optical waveguide was formed through the elastic material layer on the substrate and the resin insulating layer between layers of the outermost layer was explained Optical waveguide can acquire the same effectiveness as the above also in the multilayer printed wiring board formed through the elastic material layer between different locations from the above-mentioned multilayer printed wiring board, i.e., the resin insulating layers between layers, etc.
[0131]
[Example] Hereafter, this invention is further explained to a detail.
(Example 1)
A. The production bisphenol A mold epoxy resin (weight-per-epoxy-equivalent 469, Epicoat 1001 by oil-ized shell epoxy company) 30 weight section of the resin film for the resin insulating layers between layers, The cresol novolak mold epoxy resin (weight-per-epoxy-equivalent 215, Epiclon N-673 by Dainippon Ink & Chemicals, Inc.) 40 weight section, The triazine structure content phenol novolak resin (phenol nature hydroxyl equivalent 120, Dainippon Ink & Chemicals, Inc. make FENO light KA-7052) 30 weight section The ethyl diethylene glycol acetate 20 weight section, The heating dissolution is carried out stirring in the solvent naphtha 20 weight section. There The end epoxidation polybutadiene rubber (Nagase Brothers formation DENAREKKUSU R-45 by industrial company EPT) 15 weight section, and the 2-phenyl -4, the 5-screw (hydroxymethyl) imidazole grinding article 1.5 weight section, The pulverizing silica 2 weight section and the silicon system defoaming agent 0.5 weight section were added, and the epoxy resin constituent was prepared. After applying using a roll coater so that the thickness after drying the obtained epoxy resin constituent on a PET film with a thickness of 38 micrometers may be set to 50 micrometers, the resin film for the resin insulating layers between layers was produced by making it dry for 10 minutes at 80-120 degrees C.
[0132] The mean particle diameter by which coating of the silane coupling agent was carried out to the preparation bisphenol female mold epoxy monomer (oil-ized shell company make, molecular weight : 310 YL983U) 100 weight section of the resin constituent for through tube restoration and a front face B. By 1.6 micrometers the diameter of grain of maximum size -- SiO2 spherical particle (the Adtec Corp. make --) 15 micrometers or less CRS The viscosity prepared the resin filler of 45 - 49 Pa-s at 23**1 degree C by carrying out stirring mixing of the 1101-CE170 weight section and the leveling agent (Sannopuko PERENORU S4) 1.5 weight section for a container. In addition, the imidazole curing agent (Shikoku formation shrine make, 2E4 MZ-CN) 6.5 weight section was used as a curing agent.
[0133] C. Copper clad laminate which 18-micrometer copper foil 28 laminates to both sides of the insulating substrate 21 which consists of the glass epoxy resin with a manufacture (1) thickness of 0.8mm or BT (bismaleimide triazine) resin of a multilayer printed wiring board was used as the start ingredient (refer to drawing 3 (a)). first, the thing which drill drilling of this copper clad laminate is carried out, and nonelectrolytic plating processing is performed, and is etched in the shape of a pattern -- both sides of a substrate 21 -- a conductor -- the circuit 24 and the through hole 29 were formed.
[0134] (2) a through hole 29 and a conductor -- the conductor which washes in cold water the substrate in which the circuit 24 was formed, carries out software etching after carrying out acid cleaning, and, subsequently to both sides of a substrate, includes the through hole 29 by sending with a conveyance roll after spraying an etching reagent by the spray -- the roughening side (not shown) was formed in the front face of a circuit 24. As an etching reagent, it is imidazole copper. The etching reagent (the product made from MEKKU, MEKKU dirty bond) which consists of the (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.
[0135] (3) Next, elastic-modulus 10MPa and the elastic material layer 52 with a thickness of 25 micrometers were formed by laminating the dry film which becomes a position on a substrate (conductor circuit agenesis section) from the polyolefine system resin beforehand cut out in desired magnitude.
[0136] (4) Next, on the elastic material layer 52 formed at the process of the above (3), the organic system

optical waveguide (micro parts company make : 25 micrometers in width of face of 25 micrometers, thickness) 50 of the shape of a film which consists of PMMA was stuck so that the side face of the end of optical waveguide and the side face of a substrate 21 might gather. Attachment of organic system optical waveguide applies to the field by the side of the substrate of this organic system optical waveguide the adhesives which consist of thermosetting resin, and was performed after sticking by pressure by making it harden at 60 degrees C for 1 hour. In addition, in this example, although hardened on the conditions of 60 degrees C / 1 hour, step hardening may be performed depending on the case. It is because it is hard to generate stress by organic system optical waveguide at the time of attachment.

[0137] Furthermore, the tip formed 45-degree optical-path conversion mirror 51 in the end of optical waveguide 50 using the diamond saw which is 90 degrees of V types (refer to drawing 3 (b)).

[0138] (5) next, the following approach after preparing the resin filler indicated to Above B — after preparation -- less than 24 hours — the conductor of one side of the inside of a through hole 29, and a substrate 21 — the circuit agenesis section, the optical waveguide agenesis section, and a conductor — the layer of resin filler 30' was formed in the rim section of a circuit 24 (refer to drawing 3 (c)). That is, after pushing in a resin filler in a through hole using a squeegee, it was made to dry on 100 degrees C and the conditions for 20 minutes first. next, a conductor — the conductor with which the part equivalent to the circuit agenesis section (the optical waveguide agenesis section is included) lays on a substrate the mask which carried out opening, and serves as a crevice using the squeegee — the circuit agenesis section was also filled up with the resin filler, and the layer of resin filler 30' was formed by making it dry on 100 degrees C and the conditions for 20 minutes. subsequently, the conductor of the field of another side — the circuit agenesis section (the optical waveguide agenesis section is included) and a conductor — the layer of resin filler 30' was formed like the rim section of a circuit.

[0139] (6) the belt sander [one side / which finished processing of the above (5) / of a substrate] polish using the belt abrasive paper (Sankyo Rikagaku make) of **600 — a conductor — it ground so that resin filler 30' might remain neither in the front face of a circuit 24, nor the land front face of a through hole 29, and subsequently buffing for removing the blemish by the above-mentioned belt sander polish was performed. Such a series of polishes were similarly performed about the field of another side of a substrate. Subsequently, by 100 degrees C, it performed at 150 degrees C for 1 hour for 3 hours, 120 degrees C performed heat-treatment of 7 hours at 180 degrees C for 1 hour, and the resin filler layer 30 was formed.

[0140] thus, a through hole 29 and a conductor — the surface section of the resin filler 30 formed in the circuit agenesis section, and a conductor — the front face of a circuit 24 — flattening — carrying out — the resin filler 30 and a conductor -- the insulating substrate which the side face of a circuit 24 stuck firmly through the roughening side, and the internal surface and the resin filler 30 of a through hole 29 stuck firmly through the roughening side was obtained (refer to drawing 3 (d)). this process — the front face of the resin filler layer 30, and a conductor — the front face of a circuit 24 turns into the same flat surface.

[0141] (7) software etching after rinsing and carrying out acid cleaning of the above-mentioned substrate — carrying out — subsequently — an etching reagent — both sides of a substrate — a spray — spraying — a conductor — etching the front face of a circuit 24, and the land front face of a through hole 29 — a conductor -- the roughening side was formed in all the front faces of a circuit 24. As an etching reagent, the etching reagent (the product made from MEKKU, MEKKU dirty bond) containing the imidazole copper (II) complex 10 weight section, the glycolic-acid 7 weight section, and the potassium chloride 5 weight section was used.

[0142] (8) Next, the somewhat larger resin film for the resin insulating layers between layers than the substrate produced by Above A was laid on the substrate, and after carrying out temporary sticking by pressure and judging on pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for sticking-by-pressure time amount 10 seconds, the resin insulating layer 22 between layers was formed by sticking using vacuum laminator equipment by the approach of further the following (refer to drawing 3 (e)). That is, on the substrate, actual sticking by pressure was carried out on the degree of vacuum of 65Pa, pressure 0.4MPa, the temperature of 80 degrees C, and the conditions for time amount 60 seconds, and heat curing of the resin film for the resin insulating layers between layers was carried out for 30 minutes at 170 degrees C after that.

[0143] (9) Next, mind the mask with which the through tube with a thickness of 1.2mm was formed on the resin insulating layer 22 between layers, and it is CO2 with a wavelength of 10.4 micrometers. By gas laser, the opening 26 for the Bahia halls with a diameter of 80 micrometers was formed in the resin insulating layer 22 between layers on the beam diameter of 4.0mm, the Top Hat mode, 8.0 microseconds of pulse width, the path of 1.0mm of the through tube of a mask, and the conditions of one shot (refer to drawing 4 (a)).

[0144] (10) The roughening side (not shown) was formed in the front face containing the internal surface of the opening 26 for the Bahia halls by immersing the substrate in which the opening 26 for the Bahia halls was formed, for 10 minutes in the 80-degree C solution containing the permanganic acid of 60 g/l, and carrying out dissolution removal of the epoxy resin particle which exists in the front face of the resin insulating layer 22

between layers. Next, the substrate which finished the above-mentioned processing was washed in cold water after being immersed in the neutralization solution (product made from SHIPUREI). Furthermore, the catalyst nucleus was made for the front face of this substrate that carried out the surface roughening process (a roughening depth of 3 micrometers) to adhere to the front face (for the internal surface of the opening 26 for the Bahia halls to be included) of the resin insulating layer 22 between layers by giving a palladium catalyst (not shown). That is, the above-mentioned substrate was immersed into the catalytic liquid containing a palladium chloride (PdCl2) and a stannous chloride (SnCl2), and the catalyst was given by depositing a palladium metal.
[0145] (11) Next, into the non-electrolytic copper plating water solution of the following presentations, the substrate was immersed and the thin film conductor layer (non-electrolytic copper plating film) 32 with a thickness of 0.6-3.0 micrometers was formed on the front face (the internal surface of the opening 26 for the Bahia halls is included) of the resin insulating layer 22 between layers (refer to drawing 4 (b)).
[Nonelectrolytic plating water solution]
NiSO4 0.003 mol/l tartaric acid 0.200 mol/l copper sulfate 0.030 mol/lHCHO 0.050 mol/lNaOH 0.100 mol/lalpha and alpha'-bipyridyl 100 mg/l polyethylene glycol 0.10 (PEG) g/l [nonelectrolytic plating conditions]
It is 40 minutes [0146] by whenever [30-degree C solution temperature]. (12) Next, stick a commercial photosensitive dry film on the substrate with which the non-electrolytic copper plating film 32 was formed, lay a mask, and it is 100 mJ/cm2. The plating resist 23 with a thickness of 20 micrometers was formed by exposing and carrying out a development in a sodium-carbonate water solution 0.8% (refer to drawing 4 (c)).
[0147] (13) Subsequently, 50-degree C water washed the substrate and it degreased, with 25-degree C water, after washing with the sulfuric acid further after rinsing, electrolysis plating was performed on condition that the following, and the electrolytic copper plating film 33 with a thickness of 20 micrometers was formed in the plating-resist 23 agenesis section (refer to drawing 4 (d)).
[Electrolysis plating liquid]
Sulfuric acid 2.24 mol/l copper sulfate 0.26 mol/l additive 19.5 ml/l (made in ATOTEKKU Japan, KAPARASHIDO GL)
[Electrolysis plating conditions]
Current density 1 A/dm 2 hours 65 Part temperature 22**2 ** [0148] (14) -- a conductor with a thickness of 18 micrometers which carries out etching processing of the non-electrolytic copper plating film under the plating resist 23 with the mixed liquor of a sulfuric acid and a hydrogen peroxide, carries out dissolution removal and consists of non-electrolytic copper plating film 32 and electrolytic copper plating film 33 further after carrying out exfoliation removal of the plating resist 23 by NaOH 5% -- the circuit 25 (the Bahia hall 27 is included) was formed (refer to drawing 5 (a)).
[0149] (15) next, the thing for which the process of above-mentioned (7) - (14) is repeated -- the upper resin insulating layer between layers, and a conductor -- laminating formation of the circuit was carried out (refer to drawing 5 (b) - drawing 6 (b)). furthermore, the approach used at the process of the above (7) and the same approach -- using -- the conductor of the outermost layer -- the roughening side (not shown) was formed in the circuit 25 (the Bahia hall 27 is included), and the multilayer-interconnection plate was obtained.
[0150] (16) Next, made it dissolve so that it may become 60% of the weight of concentration to diethylene-glycol wood ether (DMDG). The oligomer (molecular weight: 4000) 46.67 weight section of the photosensitive grant which acrylic-ized 50% of epoxy groups of a cresol novolak mold epoxy resin (Nippon Kayaku Co., Ltd. make), 80% of the weight of the bisphenol A mold epoxy resin (oil-ized shell company make --) dissolved in the methyl ethyl ketone trade name: -- the Epicoat 1001 15.0 weight section and an imidazole curing agent (Shikoku -- formation -- shrine make --) trade name: -- 2 organic-functions acrylic monomer (the Nippon Kayaku Co., Ltd. make --) which are the 2E4 MZ-CN1.6 weight section and a photosensitive monomer trade name: -- the R604 3.0 weight section -- the same -- a multiple-valued acrylic monomer (the Kyoei Kagaku K.K. make --) trade name: -- the DPE6A1.5 weight section and a dispersed system defoaming agent (the Sannopuko make --) Stir the S-65 0.71 weight section for a container, mix, and a mixed constituent is prepared. The solder resist constituent which adjusted viscosity to 2.0 Pa-s at 25 degrees C was obtained by adding the benzophenone (Kanto chemistry company make) 2.0 weight section and the Michler's-ketone (Kanto chemistry company make) 0.2 weight section as a photosensitizer as a photopolymerization initiator to this mixed constituent. In addition, in the case of 60min-1 (rpm), in the case of rotor No.4 and 6min-1 (rpm), measurement of viscosity was based on rotor No.3 by the Brookfield viscometer (the Tokyo Keiki Co., Ltd. make, DVL-B mold). Moreover, a commercial solder resist constituent can also be used as the above-mentioned solder resist constituent.
[0151] (17) Next, the above-mentioned solder resist constituent was applied, for 20 minutes was performed at 70 degrees C, desiccation processing was performed to both sides of a multilayer-interconnection plate the condition for 30 minutes at 70 degrees C, and the layer of a solder REJISU constituent was formed in them.
[0152] (18) Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening for

mounting the substrate for IC chip mounting and opening for in addition to this mounting the components for surface mounts of the configuration of arbitration was drawn was stuck in the layer of a solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening of 600 micrometers of diameters of opening was formed. Furthermore, it carried out at 120 degrees C for 1 hour for 1 hour, heat-treated [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, the layer of a solder resist constituent was stiffened, and the solder resist layer 34 which has the opening 39 for mounting the substrate for IC chip mounting etc. was formed.
[0153] (19) Next, the substrate in which the solder resist layer 34 was formed was immersed in the non-electrolyzed nickel-plating liquid of pH=4.5 containing a nickel chloride (2.3x10-1 mol/l), sodium hypophosphite (2.8x10-1 mol/l), and a sodium citrate (1.6x10-1 mol/l) for 20 minutes, and the nickel-plating layer with a thickness of 5 micrometers was formed in opening 39. Furthermore, the substrate was immersed in the non-electrolyzed gilding liquid containing a gold cyanide potassium (7.6x10-3 mol/l), an ammonium chloride (1.9x10-1 mol/l), a sodium citrate (1.2x10 to 1 mol/l.), and sodium hypophosphite (1.7x10-1 mol/l) for 7.5 minutes on 80-degree C conditions, the gilding layer with a thickness of 0.03 micrometers was formed on the nickel-plating layer, and it considered as the pad 36 for surface mounts. (Refer to drawing 7 (a)) .
[0154] (20) Next, opening with a diameter of 400 micrometers which carries out mask installation and penetrates the solder resist layer 34 of one side and the resin insulating layer 22 between layers using carbon dioxide gas laser by which the through tube was formed in the location which counters optical waveguide 50 at one side (optical waveguide formation side) of the substrate in which the solder resist layer was formed was formed, and it considered as the opening 38 for optical paths by performing DESUMIA processing at the wall surface of opening further (refer to drawing 7 (b)).
[0155] (21) Next, by printing soldering paste (Sn/Ag=96.5/3.5) to the opening 39 formed in the solder resist layer 34, and carrying out a reflow at 250 degrees C, the solder bump was formed in opening 39 and it considered as the multilayer printed wiring board (refer to drawing 1).
[0156] (Example 2) Organic system optical waveguide of the shape of a film which consists of PMMA in the process of (4) of an example 1 (micro parts company make: width of face of 25 micrometers) A tip forms 45-degree optical-path conversion mirror in an end with a thickness of 25 micrometers first using the diamond saw which is 90 degrees of V types. Then, the multilayer printed wiring board was manufactured like the example 1 except having stuck the optical waveguide in which this optical-path conversion mirror was formed on the same conditions as the process of (4) of an example 1 so that the side face of that end and the side face of a substrate might gather. In addition, optical waveguide was stuck with sense to which the top face becomes larger than a base (refer to drawing 8).
[0157] (Example 3)
(1) In the example 1, the multilayer-interconnection plate was obtained like the process of (1) - (15) except having not performed the process of (3) and (4).
(2) Next, elastic-modulus 2.45x103MPa and an elastic material layer with a thickness of 50 micrometers were formed by sticking the film which becomes a position on the resin insulating layer between layers of the outermost layer (conductor circuit agenesis section) from the polyimide resin beforehand cut out in desired magnitude.
[0158] (3) Next, on the elastic material layer formed at the process of the above (2), the organic system optical waveguide (micro parts company make : 50 micrometers in width of face of 50 micrometers, thickness) of the shape of a film which consists of PMMA was stuck so that the side face of the end of optical waveguide and the side face of a substrate might gather. Attachment of organic system optical waveguide was performed on the same conditions as the process of (4) of an example 1. Furthermore, the tip formed 45-degree optical-path conversion mirror in the end of optical waveguide using the diamond saw which is 90 degrees of V types.
[0159] (4) Next, the solder resist constituent was prepared like the process of (16) of an example 1, the solder resist constituent was applied to both sides of a multilayer-interconnection plate for this solder resist constituent on the same conditions as the process of (17) of an example 1, and the layer of a solder REJISU constituent was formed.
[0160] (5) Subsequently, the photo mask with a thickness of 5mm with which the pattern of opening for mounting the substrate for IC chip mounting etc. in one side of a substrate and opening for optical paths was drawn was stuck in the layer of a solder resist constituent, it exposed by the ultraviolet rays of 1000 mJ/cm2, the development was carried out with the DMTG solution, and opening for mounting the substrate for IC chip mounting and opening for optical paths of 400 micrometers of diameters of opening were formed. In addition, opening for mounting the substrate for IC chip mounting was formed by diameter [of 600 micrometers], and pitch 1.27mm. Moreover, using the mask with which only the pattern of opening for mounting various surface mount mold electronic parts was drawn, the exposure development was performed to the field of another side on

the same conditions, and opening was formed in it. Furthermore, it carried out at 120 degrees C for 1 hour for 1 hour, heat-treated [80 degrees C / 1 hour and 100 degrees C] on the conditions of 3 hours by 150 degrees C, respectively, the layer of a solder resist constituent was stiffened, and the solder resist layer which has opening and opening for optical paths for mounting the substrate for IC chip mounting etc. was formed.
[0161] (6) Next, the pad 36 for surface mounts was formed like the process of (19) of an example 1, the solder bump was further formed like the process of (21) of an example 1, and it considered as the multilayer printed wiring board (refer to drawing 2).
[0162] (Example 4) Organic system optical waveguide of the shape of a film which consists of PMMA in the process of (3) of an example 3 (micro parts company make: width of face of 50 micrometers) A tip forms 45-degree optical-path conversion mirror in an end with a thickness of 50 micrometers first using the diamond saw which is 90 degrees of V types. Then, the multilayer printed wiring board was manufactured like the example 3 except having stuck the optical waveguide in which this optical-path conversion mirror was formed on the same conditions as the process of (4) of an example 1 so that the side face of that end and the side face of a substrate might gather. In addition, optical waveguide was stuck with sense to which the top face becomes larger than a base.
[0163] (Example 1 of a comparison) In the example 1, the multilayer printed wiring board was manufactured like the example 1 except having not performed the process of (4), i.e., the process which forms an elastic material layer.
[0164] (Example 2 of a comparison) In the example 3, the multilayer printed wiring board was manufactured like the example 3 except having not performed the process of (2), i.e., the process which forms an elastic material layer.
[0165] (1) optical waveguide and the substrate of the lower part or configuration observation of the resin insulating layer between layers, detection of (2) lightwave signals, and (3) continuity checks were performed by the following evaluation approach about the multilayer printed wiring board obtained in examples 1-4 and the examples 1 and 2 of a comparison.
[0166] the cutter cut the evaluation approach (1) configuration observation profit **** multilayer printed wiring board so that it might pass along optical waveguide, and the cross section was observed.
[0167] (2) The substrate for IC chip mounting with which the photo detector and the light emitting device were mounted in the side in which detection **** of a lightwave signal and the optical waveguide of the obtained multilayer printed wiring board are formed was connected through the solder bump so that it might be arranged in the location where a photo detector and a light emitting device counter opening for optical paths, respectively. Next, after attaching the optical fiber in the exposure from the multilayer printed wiring board side face of the optical waveguide which counters a light emitting device, attaching a detector in an exposure from the multilayer printed wiring board side face of the optical waveguide which counters a photo detector and making a lightwave signal calculate with delivery and IC chip through an optical fiber, the detector detected the lightwave signal.
[0168] (3) Like detection of the continuity-check above-mentioned lightwave signal, the substrate for IC chip mounting was connected to the multilayer printed wiring board, the continuity check was performed after that, and switch-on was evaluated from the result displayed on a monitor.
[0169] The crack was not generated in the substrate with which the multilayer printed wiring board of an example 1 is formed in the position, and two kinds of optical waveguides, the optical waveguide for light-receiving and the optical waveguide for luminescence, exist under optical waveguide and this optical waveguide as a result of the above-mentioned evaluation, either. Moreover, the crack was not generated in the resin insulating layer between layers to which the multilayer printed wiring board of an example 3 is formed in the position, and two kinds of optical waveguides, the optical waveguide for light-receiving and the optical waveguide for luminescence, exist under optical waveguide and this optical waveguide, either. Furthermore, in the multilayer printed wiring board of examples 2 and 4, the crack was not generated in optical waveguide.
[0170] Moreover, in the multilayer printed wiring board of examples 1-4, the multilayer printed wiring board which connected the substrate for IC chip mounting, could detect the desired lightwave signal when a lightwave signal was transmitted, and was manufactured by this example became clear [having sufficient lightwave signal transmission ability]. Furthermore, in the multilayer printed wiring board of examples 1-4, in the continuity check at the time of connecting the substrate for IC chip mounting through a solder bump, it was satisfactory to the conductivity of an electrical signal, and it became clear that an electrical signal can also be transmitted with a lightwave signal.
[0171] On the other hand, in the multilayer printed wiring board of the examples 1 and 2 of a comparison, although two kinds of optical waveguides, the optical waveguide for light-receiving and the optical waveguide for luminescence, were formed in the position, generating of a crack was seen by a part of substrate which exists under this optical waveguide, or resin insulating layer between layers. Moreover, in the multilayer printed wiring

board of the examples 1 and 2 of a comparison, when the substrate for IC chip mounting was connected and a lightwave signal was transmitted, the connection loss in optical waveguide was larger than the multilayer printed wiring board of an example, and the undetectable lightwave signal existed in the part. In addition, especially the big problem was not seen in the continuity check.
[0172]
[Effect of the Invention] Since the first multilayer printed wiring board consists of a configuration mentioned above, at the time of optical waveguide formation The stress applied to a substrate in case an optical-path conversion mirror is especially formed in optical waveguide can be eased. It adds to the ability to prevent the crack resulting from this stress etc. occurring in a substrate. The stress applied to optical waveguide by considering the difference of the coefficient of thermal expansion of optical waveguide, and a substrate and the resin insulating layer between layers as a cause can be eased, and the crack resulting from this stress etc. can prevent generating in optical waveguide. Therefore, the fall of the dependability of a multilayer printed wiring board is not caused from the crack generated in the substrate.
[0173] Furthermore, it can prevent that can ease the stress concerning optical waveguide and a blemish, a crack, etc. occur in optical waveguide by the above-mentioned elastic material layer at the time of optical waveguide formation in sticking the optical waveguide of the shape of a film which formed the optical-path conversion mirror beforehand. moreover — the above-mentioned multilayer printed wiring board — a conductor — since both a lightwave signal and an electrical signal can be transmitted since a circuit and optical waveguide are formed, and optical waveguide is built in in the multilayer printed wiring board, it can contribute to the miniaturization of the terminal equipment for optical communication.
[0174] Since the second multilayer printed wiring board consists of a configuration mentioned above, at the time of optical waveguide formation The stress applied to the resin insulating layer between layers in case an optical-path conversion mirror is especially formed in optical waveguide can be eased. It adds to the ability to prevent the crack resulting from this stress etc. occurring in the resin insulating layer between layers. The stress applied to optical waveguide by considering the difference of the coefficient of thermal expansion of optical waveguide, and the resin insulating layer between layers and a solder resist layer as a cause can be eased, and the crack resulting from this stress etc. can prevent generating in optical waveguide. Therefore, the fall of the dependability of a multilayer printed wiring board is not caused from the crack generated in the resin insulating layer between layers.
[0175] Furthermore, it can prevent that can ease the stress concerning optical waveguide and a blemish, a crack, etc. occur in optical waveguide by the above-mentioned elastic material layer at the time of optical waveguide formation in sticking the optical waveguide of the shape of a film which formed the optical-path conversion mirror beforehand. moreover — the above-mentioned multilayer printed wiring board — a conductor — since both a lightwave signal and an electrical signal can be transmitted since a circuit and optical waveguide are formed, and optical waveguide is built in in the multilayer printed wiring board, it can contribute to the miniaturization of the terminal equipment for optical communication.

[Translation done.]

DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is the sectional view showing typically 1 operation gestalt of the multilayer printed wiring board of the first this invention.
[Drawing 2] It is the sectional view showing typically 1 operation gestalt of the multilayer printed wiring board of the second this invention.
[Drawing 3] (a) - (e) is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of the first this invention.
[Drawing 4] (a) - (d) is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of the first this invention.
[Drawing 5] (a) - (c) is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of the first this invention.
[Drawing 6] (a) (b) is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of the first this invention.
[Drawing 7] (a) (b) is the sectional view showing typically a part of process which manufactures the multilayer printed wiring board of the first this invention.
[Drawing 8] It is the sectional view showing typically 1 another operation gestalt of the multilayer printed wiring board of the first this invention.
[Description of Notations]
100,200 Multilayer printed wiring board
21,121,221 Substrate
22,122,222 Resin insulating layer between layers
24,124,224 a conductor -- circuit
25,125,225 a conductor -- circuit
27,127,227 Bahia hall
29,129,229 Through hole
38,138,238 Opening for optical paths
34,134,234 Solder resist layer
36,136,236 Solder pad
37,137,237 Solder bump
50, 150, 250, 1150 Optical waveguide

[Translation done.]